

# Mobile Satellite Services for Public Safety, Disaster Mitigation and Disaster Medicine

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## ABSTRACT

Between 1967 and 1987 nearly three million lives were lost and property damage of \$25-\$100 billion resulted from natural disasters that adversely affected more than 829 million people. The social and economic impacts have been staggering and are expected to grow more serious as a result of changing demographic factors.

Recognizing the global consequences of these events the United Nations has designated the 1990's as "The International Decade for Natural Disaster Reduction." The major role that Mobile Satellite Services (MSS) can play in the "International Decade" is discussed .

MSS was not available for disaster relief operations during the recent Loma Prieta/San Francisco earthquake. However, the results of a review of the performance of seven other communication services with respect to public sector operations during and shortly after the earthquake are described. The services surveyed were: public and private telephone, mobile radio telephone, non-cellular mobile radio, broadcast media, CB radio, ham radio and government and non-government satellite systems.

The application of MSS to disaster medicine, particularly with respect to the Armenian earthquake is also discussed.

## INTRODUCTION

The stakes are high. The social and economic impacts of natural disasters have been and will continue to be enormous. Disasters respect no boundaries or economic classes. The distance from the epicenter of an earthquake is not necessarily an

indicator of the full damage potential. A destructive earthquake in Tokyo, Japan can, for example, be economically devastating to the United States(1). A big quake has hit Tokyo roughly every 70 years for four centuries: 1633, 1703, 1782, 1853, 1923, and -- 1993?---

The world wide seriousness of the problem is the reason the U.N. established the "International Decade for Natural Disaster Reduction" beginning in 1990.(2,3) Its goal is to promote cooperative efforts between nations to reduce the ravages of all types of natural hazards. Individual countries, including the United States, have declared their own "National Decades" consistent with the international program.

Satellite communications and the application of remote sensing technology can play major roles in reducing the devastating effects of natural disasters by dramatically improving hazard and risk assessment, disaster preparedness, early warning and onset and post disaster relief operations.(4,5)

For most emergency response users, the cost of satellite terminals and service charges have been too expensive. Now, new advances in communications technologies, the integration of satellite and terrestrial services, mass production of user terminals and market forces should dramatically reduce costs and alleviate the problems of affordability, universal access and coverage.

## DISASTER MITIGATION - LOMA PRIETA / SAN FRANCISCO EARTHQUAKE

### Background

Loma Prieta was the epicenter of the earthquake that affected the Santa Cruz/San Francisco corridor on October 17, 1989. It was considered by many to



be only a "rehearsal" for the "real thing".

Within moments of the major tremor, communications difficulties common to most major, rapid onset, disasters were experienced during the first few hours. The application of satellite communications for disaster management during the earthquake was conspicuous by its absence.

A review was conducted by PSSC, with a grant from AMSC, to provide information on the performance of seven different communications services used by public service and emergency response organizations during and shortly after the earthquake(6). These organizations included: health care facilities, fire departments, public utilities and transportation, police, the Red Cross and public schools.

Emphasis was placed on identifying communications failure modes and vulnerabilities. It should be noted that, in general, communications for most critical situations was adequate except for the first few hours.

The quake effects were unusual in that structural damage to communications facilities was relatively light. Had the earthquake occurred a few hours earlier, lasted about ten seconds longer and occurred several miles further north, casualties and damage to structures, including communications facilities, would have been dramatically higher.

### **Sampling of Findings, Observations and Conclusions(6)**

**Telephone outages.** The adverse effects of the breakdown of the public telephone system during the first few hours was a dominant theme. Outages were primarily due to overloaded circuits and lasted anywhere from several hours to two weeks. Dial tones were affected by power outages and overloads.

Receivers were knocked off their mounts exacerbating the problem.

Long distance calls into the area were particularly difficult. "Essential service", which usually exempts emergency-services from local telephone company "line-load control", did not get priority service on long lines. 911 service was inoperative in many areas and, in some cases, for several days.

Structural damage to communications facilities was relatively minor and network infrastructures appeared to remain intact.

**Cellular mobile radio telephone.** Cellular companies loaned 2000 portables to many public safety organizations. Most who used the units and service appeared pleased with the results.

Many organizations indicated that the purchase of cellular radios would be included in their future budgets.

Cellular phones became the "work horse" in the field. They were also used extensively to solve "... the interoperability problem of incompatible radio frequencies among cooperating agencies...."

Despite general enthusiasm for the cellular phone there was concern by most that cellular towers were vulnerable to structural damage and that the network was also vulnerable to overloading. The cell site at the Emergency Operations Center did, in fact, overload regularly. A few sites were damaged and several experienced overload outages. Portable sites were brought in quickly where needed.

**Facsimile/Data Links.** The use of facsimile "exploded" whenever the phone lines worked. This tied up valuable voice circuits for lengthy transmissions, sometimes as many as 10 to 15 pages. Interest was expressed in using some sort of burst mode transmission to reduce the length of transmission time.

There is a need for expanded use of data links and information networking for linking personal computers, FAX machines, information management systems, etc..

**Power supplies.** Power supply problems were common and generally serious. Many could have been avoided.

**Mobile to mobile.** This capability was considered very important. In several cases, where base stations were not functioning, vehicles were used as base stations. Coordination within and between organizations (eg. fire/police) was carried out via mobile to mobile operations.

**Smoke Detectors.** The inability to reach San Francisco by phone created the potential for major fire damage and loss of life since some and possibly



many of San Francisco's smoke detectors are monitored in locations outside of San Francisco including Chicago. The location of an alarm in San Francisco that is monitored in Chicago would normally be phoned from Chicago to the nearest fire station in San Francisco. This problem is under study by the Fire Department.

Remote monitoring of burglar alarms may present a similar problem. However, this was not verified.

**Vulnerability of public switched networks.**

Public switched networks appear to have emerged relatively intact and in good shape. However, they are growing more vulnerable to outages, according to a controversial conclusion of the National Research Council(7).

**Special data, position location and remote sensing needs.** Chemical spills were observed in some school laboratories. This danger could have some very serious data and remote sensing implications with respect to hazardous materials transfer and storage. Given a more serious quake, problems of fractured storage tanks, leaky gas lines and damaged transporters all become problems of immediate detection, location, assessment and emergency response.

Highway status (damage and traffic information) becomes critical for effective emergency response measures. This information would also be critical for managing the transport of medical, water, food and other relief supplies.

**Transportation.** Only the BART System was reviewed. However a complete review of all public transportation operations would be useful since the transport of search and rescue teams, relief supplies, heavy equipment, evacuees, etc. is almost solely dependent on their functioning.

Additional concerns are tunnel communications, prisoner transport, law and drug enforcement operations. Encrypted or scrambled communications are needed for these functions.

**Accurate and Timely Information.** The inability to obtain and disseminate useful, accurate, real time information, that is not out of context, on casualties, damage, and resources needed was identified as a major problem by most of the respondents.

**Human factors.** Attitudes, habits, skills and resistance to change of field and supervisory

personnel make it very difficult to introduce new communications systems or devices during a crisis. Therefore, any new equipment, satellite or terrestrial, must be simple and look like, sound like, and feel like a telephone or existing mobile radio.

**Back-up communications planning.** The public telephone and mobile radio are, by far, the most important modes of communications for emergency response. Steps are being taken to "harden" these systems to minimize disaster damage. Back-up plans seem to be emphasizing cellular and caches of mobile radios both cellular and non-cellular. Other back-up modes being considered are: HF radio, satellite communications, redundancy and alternate routing.

Since terrestrial back-up is being emphasized major outages can be expected for everyone, given the occurrence of a quake larger than Loma Prieta.

**Satellite role.** There is a general, almost universal, awareness that satellite systems can play a major role in disaster management. It is firmly believed that, ultimately, it may be the only means of retaining or immediately reconstituting communications during a major disaster.

This awareness, however, does not seem to be translated into implementation plans at the local level. The State level appears to be exploring the concept of integrating satellite technology into their communications networks but probably still has a long way to go before an operational system is realized. Planning for satellite systems integration seems to be furthest developed at the Federal level.

The California earthquake was a typical example of a situation in which an integrated satellite/terrestrial capability would have been invaluable. It could have linked the State with local communities, provided coverage for emergency medical services, provided long distance service for priority traffic, off-loaded non-emergency traffic from public safety channels and provided the much needed additional communications capacity all of the local communications systems critically needed. Vital communications could have been reconstituted within minutes instead of hours or days

**Other areas of special interest not covered in this review.** The roles and performance of marine communications in the Bay area, particularly if a quake of much larger magnitude were to hit the Bay



area; the failure potential of air traffic control communications in or near the airports; and the use and effectiveness of Tsunami or Tidal Wave warning systems for California's coastal areas.

## **DISASTER MEDICINE - SPACE BRIDGE - ARMENIAN EARTHQUAKE**

### **Background**

The Armenian earthquake, which occurred in early December 1989, caused more than 150,000 casualties as well as enormous, wide spread, destruction. The economic impact to the Soviet Union has been estimated at 20 to 40 billion dollars.

Under the auspices of the US/USSR Joint Working Group on Space Biology and Medicine, NASA's Communications and Life Sciences Divisions initiated, funded and implemented a "Telemedicine Spacebridge" which provided satellite video, voice, FAX and telex links between Soviet and US medical teams for treatment of Armenian earthquake victims(8,9).

Initial satellite communications links consisted of one-way video, two-way audio, data, fax and telex. It was the product of a cooperative effort on the part of the COMSAT Corporation, INTELSAT, AT&T, Satellite Transmission and Reception Specialists and NASA's Goddard Space Flight Center in the US, and the Soviet Ministries of Post and Telecommunications and Health.

The US physicians and specialists that participated in the spacebridge project provided consultative support to more than 200 Soviet physicians, primarily in the areas of reconstructive surgery, rehabilitation and psychiatric care for post-traumatic stress disorder. The four month project was considered highly successful by the participants and they recommended that the concept be continued and expanded.

Participating US centers were: (a) The Uniformed Services University of the Health Sciences in Bethesda, MD, (b) The University of Maryland Institute of Emergency Medical Services Systems, Baltimore, MD, (c) The University of Texas Health Science Center, Houston, Texas, and (d) LDS Hospital and the University of Utah, Salt Lake City, UT. The Public Service Satellite Consortium (PSSC) provided telecommunications

applications support to NASA and the USSR Ministry of Health.

In June, the Soviet Ministry of Health urgently requested technical assistance from NASA and PSSC for Soviet medical experts treating victims of a gas explosion near the city of Ufa in the Ural region. Twelve hundred casualties resulted when sparks from a passenger train ignited gas escaping from a ruptured line nearby.

NASA and PSSC responded in real time by extending the Space Bridge to include black-and-white slow scan video and voice communications between Ufa and Yerevan, Armenia for retransmission through the space bridge to the US Hospitals which then provided consultation to burn specialists in Ufa. The slow scan equipment was donated by Colorado Video, Inc. in CO.

It is significant to note that the application of slow scan and audio technology in Ufa was constrained to using only existing voice circuits and infrastructure. This permitted the rapid deployment of low-cost interactive equipment to a region whose existing communications network could not accommodate full-motion video. MSS can provide this kind of low cost, real time deployment and capability.

Several participants, including PSSC, are involved in proposals to continue and expand the spacebridge concept on a worldwide basis.

### **A CHALLENGE**

More than 20 years of development, user experiments, regulatory proceedings, political processes and countless studies have been completed. This "new" technology will finally be integrated into useful economically viable systems worldwide serving the public and private sectors.

Will public sector and government institutions and funding sources recognize this opportunity? Will they take the actions needed to enable them to apply this technology in ways described in this and other papers presented at this and other related conferences?(10,11)

Will service and hardware providers facilitate the use of the Mobile Satellite Service by the public sector? Will the providers remember that the U.S. Government and public sector elements facilitated



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the commercialization of the MSS and that some reciprocity might be of benefit to all.

This is an era of increasing world-wide social, economic, technological and political interdependencies. "... The Decade is an opportunity for the world community, in a spirit of global cooperation, to use the considerable existing scientific and technical knowledge to alleviate human suffering and enhance economic security."(3)

## REFERENCES

1. Lewis, M.. *How a Tokyo Earthquake Could Devastate Wall Street*. June 1989. Manhattan,inc. pages 69-79
2. National Research Council. *Confronting Natural Disasters: An International Decade for Natural Hazard Reduction*. 1987. National Academy Press. Washington, D.C.
3. Kreimer, A. and M. Zador (eds.). *Colloquium on Disasters, Sustainability and Development: A Look to the 1990s*, Environmental Paper No. 23. December 1989 (Washington, DC: The World Bank Policy Planning and Research Staff). Note: This is an internal document.
4. Scott, J. C. and J. Freibaum. (PSSC) *Mobile Satellite and Remote Sensing Technologies: Tools For Disaster Mitigation in the Next Decade*. Published in BOSTID Developments, National Research Council. Fall 1988
5. Public Service Satellite Consortium. Testimony on: *The Application of New Space Technology to Reduce the Adverse Effects of Natural Disasters and Dramatically Improve Disaster Medicine and Rural Health Care*. before the Senate Subcommittee on Science, Technology and Space. October 19, 1989.
6. Freibaum, J., *Review of the Effectiveness of Communications During and Shortly After The Loma Prieta, California Earthquake*. February 1990. Public Service Satellite Consortium through a grant from the American Mobile Satellite Corp.. Washington, D.C.
7. National Research Council. *Growing Vulnerability of the Public Switched Networks: Implications for National Security Emergency Preparedness*. 1989 National Academy Press, Washington D.C.
8. U.S. - USSR Joint Working Group on Space Biology and Medicine. *U.S. - U.S.S.R. Telemedicine Consultation Spacebridge to Armenia and UFA*. Presented at Third Joint Working Group Meeting December 1-9, 1989. Washington, D.C.
9. Scott, J.C., Freibaum, J.(PSSC). *Facilitating The Growth of International Emergency Medical Assistance Via Satellite*. January 14-17, 1990. Proceedings of the 1990 Pacific Telecommunications Council. Honolulu, Hawaii.
10. Office of the United Nations Disaster Relief(UNDRO) (assisted by the Public Service Satellite Consortium). *International Conference on Disaster Communications*. April 1990. Geneva, Switzerland.
11. Public Service Satellite Consortium (PSSC) (organizer). *Symposium on Disaster Communications*. April, 1989. Sponsored by American Mobile Satellite Corp., COMSAT, GEOSTAR, INMARSAT, McCaw Cellular Communications, NASA, and QUALCOMM. Ontario, California.